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# Project Summary

# Characterization of Nitrous Oxide Emission Sources

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**Nitrous oxide ($N_2O$) is both a greenhouse gas and a precursor of nitric oxide (NO) which destroys stratospheric ozone. This study presents a global $N_2O$ inventory based on re-evaluation of previous estimates and additions of previously uninventoried source categories. The best estimate of anthropogenic $N_2O$ is 5.7 teragrams per year (Tg/yr), which is still much lower than natural source emissions. Much uncertainty remains about estimates for many source categories. Inadequate data are available for some categories, while others are limited by a lack of reliable functional models of factors affecting emission rates.**

***This Project Summary was developed by the National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).***

## Introduction

Nitrous Oxide ($N_2O$) is the largest source of stratospheric nitric oxide (NO), which destroys stratospheric ozone, and the fourth most significant greenhouse gas, which contributes to global warming. Levels of atmospheric $N_2O$ are increasing by about 0.2% per year.

Previous studies have attempted to quantify the global $N_2O$ budget for the larger sources. Many of these estimates were based on limited data and fairly broad assumptions. The objectives of this study were to re-evaluate previous estimates using new data and more refined approaches, and to quantify emissions from some of the smaller source categories. In addition, country-specific estimates were developed for the anthropogenic sources. For a few categories, new data were gathered from industry and the government.

The information contained in this report is based on original calculations and analyses of existing data. In addition, individuals recognized as experts in various fields were contacted, and the information they provided was either used directly or to identify literature references not already reviewed. For the most part, the revised emissions estimates presented in this report are based on a re-evaluation of previously published data, but new data are included in a few cases.

## Results

Fourteen source categories, classified as anthropogenic and biogenic (or natural), were identified as potentially substantial contributors of global $N_2O$. These source categories are presented in Table 1, along with their estimated $N_2O$ emissions and, where possible, an estimated emissions range. Natural sources were found to be by far the largest emitters of $N_2O$. Although anthropogenic sources emit smaller amounts of $N_2O$, these sources can be controlled to some extent.

The overall result of this study was to revise the previous best estimate of $N_2O$ emissions from all anthropogenic sources of 8 to 5.7 Tg/yr. However, this lower estimate is still within the 5-10 Tg/yr previous best estimate range.

Estimates of $N_2O$ emissions associated with adipic acid production were reduced

***Table 1.*** *Summary of Global $N_2O$ Emissions by Source Category*

| *Source Category* | *$N_2O$ Emissions (Tg/yr)*[a] |
|---|---|
| *Anthropogenic Sources* | |
| *Biomass Burning*[b] | *1.5 (1.3-1.6)* |
| *Aquifer Contamination*[b] | *1.1 (0.7-1.5)* |
| *Municipal Wastewater* | *0.7 (0.2-1.2)* |
| *Stationary Combustion Sources* | *0.5 (0.3-0.9)* |
| *Livestock (agricultural)* | *0.5 (0.3-1)* |
| *Adipic Acid (Nylon) Production* | *0.4 (NA)* |
| *Fertilizer Use* | *0.3 (0.1-1.9)* |
| *Climatic Feedbacks*[b] | *0.3 (0.0-1.0)* |
| *Mobile Combustion Sources* | *0.2 (NA)* |
| *Nitric Acid Production* | *0.2 (0.07-0.30)* |
| *Municipal Waste Combustion* | *0.012 (0.012-0.013)* |
| *Sewage Sludge Incineration* | *0.005 (NA)* |
| *Total* | *5.7* |
| *Natural Sources* | |
| *Soils* | *17.3 (11.2-21.9)* |
| *Oceans*[b] | *3.3 (2.2-4.4)* |
| *Total* | *20.6* |

[a] *Variability or range of estimated emissions is shown in parantheses; in some cases (shown as NA), available data were not sufficient to estimate a range. Lack of a range does not imply greater certainty in the estimate.*

[b] *Estimates calculated by other than preparers of this report*

by 40% based on new data from U.S. facilities. Previous estimates may not have included the effects of emissions controls now in place at many of these facilities. Emisons from mobile sources may also have been overestimated by using measurements from automobiles in California. California (and the U.S. in general) have a greater proportion of controlled vehicles, which in some cases emit more $N_2O$ than uncontrolled vehicles. Thus, the new estimates for this category are also much lower.

Average emissions estimates for stationary coal combustion and fertilizer use were also reduced. New emission factors and 95% confidence intervals were developed for these categories. The estimates for municipal wastewater emissions in this report are lower than previous estimates, which assumed that municipal wastewater systems are universal. In fact, a large population uses other methods of waste disposal, most of which do not result in conditions conducive to $N_2O$ formation.

$N_2O$ emissions from nitric acid production, municipal solid waste (MSW) combustion, and sewage sludge incinerators are quantified here for the first time. MSW combustors and sludge incinerators are both relatively small sources. However, they may become important in the future as waste management practices change.

The largest anthropogenic source of $N_2O$ is biomass burning, accounting for about 27% of global $N_2O$ emissions. However, given the uncertainty of the estimates for most catgories, the relative importance of the anthropogenic source categories is difficult to specify.

Recommendations for improving future emissions inventories are included in this study. Estimates for many source categories could benefit from more field studies to obtain better emission factors and activity data. Some of these source categories, such as municipal wastewater and aquifer contamination, are potentially large contributors to global $N_2O$ emissions. For some categories, such as fertilizer use, obtaining more data is unlikely to significantly reduce the range of possible emissions. This will be accomplished only by identifying the main factors affecting emission rates and developing functional relationships. This, in turn, will require development of better activity data sets that quantify the key variables.

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*The complete report, entitled "Characterization of Nitrous Oxide Emission Sources," (Order No. PB95-246252; Cost: $27.00, subject to change) will be available only from:*

*National Technical Information Service*
*5285 Port Royal Road*
*Springfield, VA 22161*
*Telephone: 703-487-4650*

*The EPA Project Officer can be contacted at:*

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